

WE CLAIM:

1. A combination tool for assembling a part to a workpiece with a robot following a programmed series of predetermined motions including picking the part from a supply and transferring the part to an assembly position aligned on an operating axis wherein a mounting surface of the part engages a target surface of the workpiece, the robot including a tool support, the combination tool comprising:

a base matching the tool support of the robot;

a workpiece arm including a workpiece target surface preparation module;

a part delivery arm including a part gripper capable of releasably holding the part with mounting surface exposed;

a part mounting surface preparation module supported by the base between: an engaged position in contact with the part mounting surface while the part is held in the part gripper; and a disengaged position retracted from the part mounting surface; and

an indexing module supported on the base, the indexing module alternating between: a preparation position; and said assembly position, wherein:

the indexing module in the preparation position

supports the workpiece arm aligned on the operating axis while simultaneously supporting the part delivery arm aligned with the part mounting surface preparation module:

the indexing module in the assembly position supports the workpiece arm withdrawn from the workpiece while simultaneously supporting the part delivery arm aligned on the operating axis; and wherein

at least one of: the workpiece target surface preparation module; the part gripper; and the part mounting surface preparation module, are releasably mounted with a common tool interface.

2. A combination tool according to claim 1 wherein said common tool interface includes a releasable mechanical mount including at least one of: an mechanical mount opening; a mechanical mount boss; locating pin; and positioning pin.

3. A combination tool according to claim 1 wherein the common tool interface includes a releasable electrical connector including at least one of: an electrical power connector; and a communications control connector.

4. A combination tool according to claim 1 wherein the common tool interface includes a releasable fluid power ports including at least one of: a pneumatic power port;

and a hydraulic power port.

5. A combination tool according to claim 1 wherein at least one of: the workpiece arm; the part delivery arm; and the part mounting surface preparation module; includes a load cell in communication with the robot.

6. A combination tool according to claim 1 wherein the part mounting surface preparation module is selected from the group consisting of: a heater; an adhesive applicator; a sealant applicator; an abrader; a cutter; and a surface grinder.

7. A combination tool according to claim 1 wherein the workpiece target surface preparation module is selected from the group consisting of: a heater; an adhesive applicator; a sealant applicator; an abrader; a cutter; and a surface grinder.

8. A combination tool according to claim 1 including a workpiece target surface scanning module, with offset means for communicating workpiece target surface position data to the robot, selected from the group consisting of: a laser scanner; an optical scanner; a sonar scanner; and an infrared scanner.

9. A combination tool according to claim 1 wherein the indexing module includes a shaft journaled to the base, the shaft supporting the workpiece arm and the part delivery arm; and includes a rotary actuator operably engaging the

shaft.

10. A combination tool according to claim 9 wherein the part mounting surface preparation module comprises a linear actuator.

11. A method of assembling a part to a workpiece with a combination tool supported on a robot, wherein a mounting surface of the part is assembled on a target surface of the workpiece,

wherein the combination tool comprises:

a base matching the tool support of the robot;

a workpiece arm including a workpiece target surface preparation module;

a part delivery arm including a part gripper capable of releasably holding the part with mounting surface exposed;

a part mounting surface preparation module supported by the base between: an engaged position in contact with the part mounting surface while the part is held in the part gripper; and a disengaged position retracted from the part mounting surface; and

an indexing module supported on the base, the indexing module alternating between: a preparation position; and said assembly position, wherein:

the indexing module in the preparation position supports the workpiece arm aligned on the operating axis while simultaneously supporting the part delivery arm aligned with the part mounting surface preparation module:

the indexing module in the assembly position supports the workpiece arm withdrawn from the workpiece while simultaneously supporting the part delivery arm aligned on the operating axis; and wherein

at least one of: the workpiece target surface preparation module; the part gripper; and the part mounting surface preparation module, are releasably mounted with a common tool interface,

and wherein the method comprises:

indexing to the assembly position;

picking a part with the part gripper on the part delivery arm from a part supply station;

indexing arms to the preparation position;

simultaneously: engaging the part mounting surface with the part mounting surface preparation module; and engaging the workpiece target surface preparation module with the target surface;

indexing to the assembly position;

engaging the prepared part mounting surface with the prepared workpiece target surface; and

releasing the part gripper and withdrawing the tool from the part/workpiece assembly.

12. A method according to claim 11 including the step of:

releasing at said common tool interface and storing a first tool, selected from the group consisting of: a load cell; a part gripper; and a workpiece target surface preparation module, in a tool storage area; and

engaging at said common tool interface and removing a second tool, selected from the group consisting of: a load cell; a part gripper; and a workpiece target surface preparation module, from said tool storage area.

13. A method according to claim 11 wherein at least one of: the workpiece arm; the part delivery arm; and the part mounting surface preparation module; includes a load cell in communication with the robot, the method including:

communicating load data from the load cell to regulate pressure applied to at least one of: the part; and the workpiece.

14. A method according to claim 11 wherein said common tool interface includes a releasable mechanical mount

including at least one of: an mechanical mount opening; a mechanical mount boss; locating pin; and positioning pin.

15. A method according to claim 11 wherein the common tool interface includes a releasable electrical connector including at least one of: an electrical power connector; and a communications control connector.

16. A method according to claim 11 wherein the common tool interface includes a releasable fluid power ports including at least one of: a pneumatic power port; and a hydraulic power port.

17. A method according to claim 11 wherein the part mounting surface preparation module and the workpiece target surface preparation module are each selected from the group consisting of: a heater; an adhesive applicator; a sealant applicator; an abrader; a cutter; and a surface grinder.

18. A method according to claim 11 wherein the part and workpiece are thermal plastic and wherein the part mounting surface preparation module and workpiece target surface preparation module are hot plate heaters.

19. A method according to claim 18 wherein the workpiece is a plastic gas tank.